Medieval Castles and their Landscape

A Case Study Towards Historic Reconstructions

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Scientific research concerning castles is most often centred on the object of the castle itself. Research concerns the history of the castle, its building phases, the structure of the 'castle' building or the archaeology of the main castle. The geographical context of the castle is often ignored. But to understand a castle not only as a building but as part of the social reality of its day it is necessary to put it back into its geographical context. That means to investigate the landscape surrounding the castle and to look at settlements, streets, rivers etc. and their position in the landscape in connection with the castle. That leads directly to another question the art historian has to deal with: A castle is a piece of architecture, it has real functions, but it is also built to impress people, to show power, and therefore the parts of the castle are designed in specific ways. And castles are often built and designed in a process of action and reaction – if my neighbour builds a castle at his border, I have got to build one as well, and mine will be seen from his castle, and therefore it must be impressive as well!

It is often impossible to understand these aspects in our modern landscape because too much has changed: there are woods surrounding the ruins of a castle, so that you cannot see it properly, the streets we use were made in the late 19th and the 20th centuries and the medieval streets are no longer in use. Most important is that the castle itself has seen many building phases during the medieval period which changed its appearance, and afterwards it became a ruin or sometimes it was even reconstructed in a romantic style in the 19th century. So, if we want to understand the way the castle presented itself to the passer-by during the medieval period we have to do a lot of reconstruction and we have to analyse the landscape surrounding the castle.

In former days, researchers had to wait until wintertime to be able to recognize at least some structures in the woods and to try to guess what could have been seen from a tower which no longer exists. Today, LiDAR-scans give us the opportunity to analyse landscape in a scientific way at any time of the year.

LiDAR-Scans are produced by scanning the ground of the earth from a plane, and by the kind of reflection and the time it takes you can create a three-dimensional model of the earth, without any trees or bushes – and without any buildings. With the help of these models, which may be as accurate as some decimetres, you can for example recognize old streets or paths which are no longer in use now, but which may have been the historical way leading to a castle. But LiDAR-scans give us yet another opportunity: with GIS-software it is possible to analyse exactly which areas you could have seen from a specific point, and it is even possible to raise the position of the viewer, so as if they were standing on the top of a tower.[1]

In addition, Computer Vision and Photogrammetry offer some more possibilities for the analysis of historic monuments. If there are any physical remains of a castle existing, it can be acquired as a three-dimensional model, only by taking a series of photos from particular directions. Basically everything one has to do is to take pictures of the object from all directions, but in the case of large-scale objects like a castle it is unfortunately mandatory to have some views from elevated positions, therefore it is necessary to have a bucket truck or an Unmanned Aerial Vehicle (UAV), usually a small multi-rotor drone.[2] Smaller objects, like capitals or other ornaments of the building require less effort, especially when they are reachable from all important sides. The resulting 3D model of the castle can be integrated in a LiDAR-scan if it contains geo-referenced control points, which leads to a scaled and oriented model for further processing in a GIS-software. However, any 3D acquisition method can only scan what is still there to be scanned today, which is in most cases dramatically different from the castle in the past. This is where synthetic 3D reconstruction comes into play, which attempts at creating scientifically valid 3D models of the castle and its landscape in mediaeval times, based on both the 3D scans and on educated guesses (expert knowledge). That is why LiDAR-scans, GIS-software, and 3D modelling software, are very important in the analysis of castles by the historians or the art historians, as the following three examples will demonstrate.[3]

The first example concerns the famous Castle Eltz in Rhineland-Palatinate, situated near the River Moselle, which was besieged in the years from 1331 up to 1337 (fig. 1). In this conflict, the so-called 'Eltzer Fehde', the nobles of the castles Eltz, Waldeck, Schöneck and Ehrenburg, all situated in the area in the west of Koblenz, acted against the Archbishop of Trier. We do not know the exact reason for the conflict but it seems to have been an act of defence of the nobles who tried to withstand Archbishop Balduin of Trier who tried to expand his power on both shores of the River Moselle.[4] Most probably the fighting started in summer 1331, and the nobles made their peace with the archbishop on 9 January 1336. Johann of Eltz only made his peace with Archbishop Balduin nearly two years later, on 16 December 1337.[5]

As a siege castle (called Trutz-Eltz or Balden-Eltz) is situated near Castle Eltz, the literature often says that Archbishop Balduin erected the siege castle in this conflict and that there he positioned a trebuchet which threw stones on Castle Eltz. As there was no archaeological or art historical research on Trutz-Eltz and a written source from 1453 tells us that the siege castle was ruined,[6] it is taken for granted that the building still looks the way it did when it was erected during the siege. Therefore authors always try to explain the way the siege castle looks just based on military aspects.[7] In two papers published in 2012 and 2013 Achim H. Schmidt, Koblenz, and Olaf Wagener could show that these 'facts' should probably be revised in some of the more important aspects.

Fig. 1 Castle Eltz seen from the North (2008).

All the findings and the former buildings and structures surrounding Castle Eltz were part of this analysis and the written sources were also taken into consideration, and analysed critically. The authors showed that there is another castle to the west of Castle Eltz, called 'Alte Burg'. Finally it became obvious that this castle must have been in use as a siege castle in the 1330s as well. The reason for this conclusion were the stone balls which were launched by the trebuchet – most of them were found in the western part of Castle Eltz – that is where you would expect them to be if the trebuchet stood in the 'Alte Burg' (figs. 2 and 3).

Fig. 2 'Alte Burg', main plateau (2008).

Fig. 3 Castle Eltz as seen from the 'Alte Burg' (2008).

It could also be shown that the siege castle Trutz-Eltz had been built in three stages, all of which date from the time of the siege. Maybe this was a position for a trebuchet as well, at least as long as the main tower had not yet been built, but that was obviously not the only purpose of that building.

Finally the written sources also show that the siege took part in different stages. The so-called 'Gesta Trevirorum' written only a short time after the events tell us for the year 1331:

> 'Contra quos [i.e. the nobles of Eltz, Waldeck, Schöneck and Ehrenburg] dominus Baldewinus exercituali potentia acies direxit, Eltz circumdedit, et Baldeneltz a fundamento constructum, quo ejus potentiam nihilavit, mirabiliter firmavit.'[8]

This passage can be interpreted as saying that Archbishop Balduin in a first step surrounded Castle Eltz (circumdedit) and that he only afterwards started to build the siege castle Trutz-Eltz. These theories can now be checked on their plausibility with the help of LiDAR-scans. For this purpose a short description of the terrain and the buildings will be given, so that the reader can easily understand the scans.

Castle Eltz is situated in the Eifel in the narrow valley of the River Elz [sic!] which winds its way to the River Moselle in the south. The castle has been erected on a small rock surrounded by the river on three sides. It is the last part of a ridge which stretches from northeast to southwest in the Elz valley. The surrounding ridges are nearly one hundred metres higher than the castle and they have a distance of approximately 200 metres to the castle. The castle was probably built in the 12 century[9] and in those days it was rather safe on its rock as neither the counterweight trebuchet nor firearms had been introduced in central Europe. But after the introduction of the counterweight trebuchet in the German speaking areas at the beginning of the 13th century it was possible to launch stone balls weighing more than 50 kg to distances of several hundred metres.[10] In consequence the place where Castle Eltz was erected had become vulnerable.

At the moment it is impossible to try to reconstruct what Castle Eltz looked like in the time of the siege in the early 14th century because there has been no archaeological or art historical research campaign until now and the castle is still in use and has seen many construction programmes since the Middle Ages.[11] The tower 'Platt-Eltz' in the northwest of the castle is definitely older than the siege and some parts of the outer defences in the north and west must also be older. Because of the structure of the rock it is very probable that the castle has always used the whole rock although its present state with the big neighbouring towers creates a misleading image of the castle in the 1330s. There are no signs of damage to be found in the castle which could have been caused by the siege.

The most impressive relic of the siege is the ruin of Trutz-Eltz. It is situated on the same ridge as Castle Eltz but is 220 metres distant and about 40 metres higher. So the castle whose terrain comprises about 1300 m², has the classical location of a siege castle (figs. 4 and 5). It mainly consists of a donjon built of slate, 11 × 11 metres square and 11.5 metres high, and a wall, a so-called 'Schildmauer' or chemise which leads from the donjon to the west. In the south is a small yard and in the north an outer ward or 'Zwinger'.[12]

Fig. 4 Castle Eltz on the left, Trutz-Eltz on the right (2008).

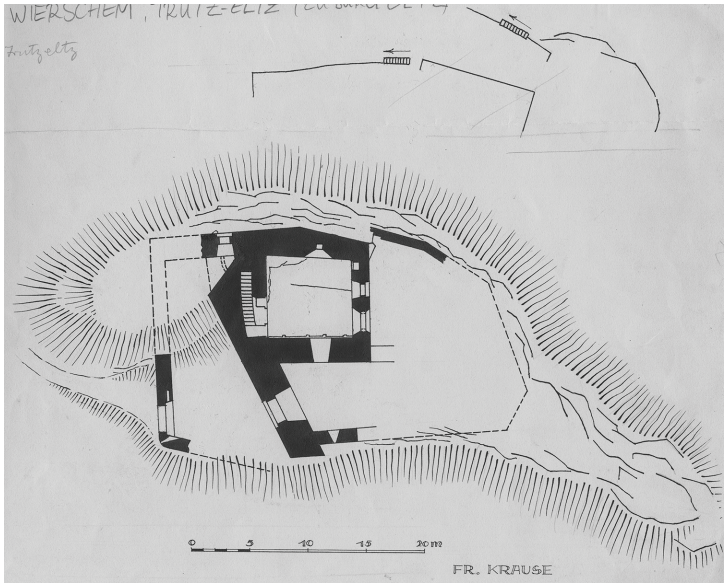

Fig. 5 Plan of castle Trutz-Eltz as drawn in the 1930s – until now it has always been published without the upper parts of the plan showing stairs and terraces in the slope.

Trutz-Eltz probably developed in three stages out of a simple fortification. Because of sub-structures in the west, especially the southern part of the fortification had a plateau big enough to place a trebuchet on it in the first phase.[13] The development of the castle took place in several steps, including changing plans. In the last stage the fortification was totally restructured. Maybe the reason was that it was no longer intended to have a mere siege castle (which normally would be destroyed after the siege[14]) but to build a 'real' castle in anticipation of a political solution. The written sources suggest that the building process stopped after the end of the siege, and art historical research did not show any parts which could be younger than the 14th century (figs. 6 and 7).

Fig. 6 Trutz-Eltz seen from the west (2008).

Fig. 7 Trutz-Eltz seen from Castle Eltz (2008).

Another fortification can be found to the west of Castle Eltz on a rock in a loop of River Elz. This fortification is called 'Alte Burg' (i.e. old castle) and was regarded as pre-medieval. It is situated in about 330 metres distance from Castle Eltz and at the same height; a ridge which descends between both castles from southwest is lower so that it is possible to look from each castle to the other directly (fig. 8).

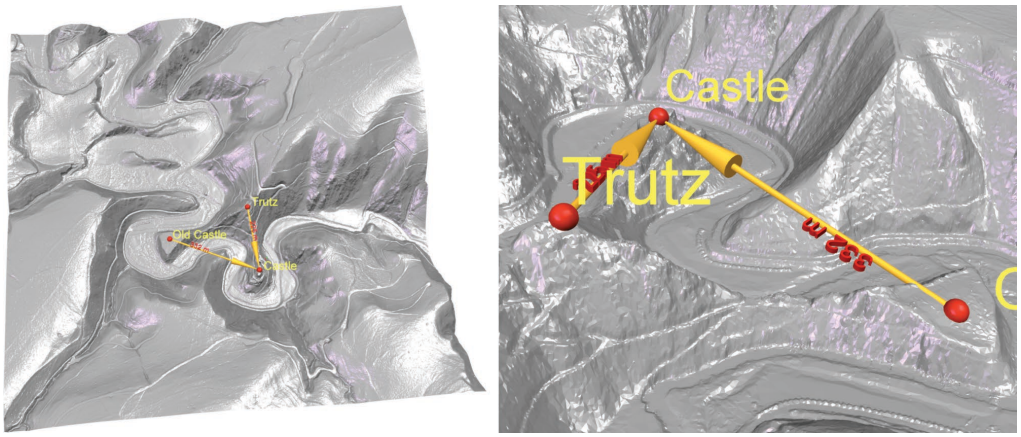

Fig. 8 Castle Eltz, GML-Rendering of LiDAR-scan of the surrounding landscapes and distances to Trutz Eltz (225 m) and 'Alte Burg' (332 m), (2010).

The ridge where the 'Alte Burg' is situated lies to the southeast and is part of the ridge where Trutz-Eltz can be found, too. It is an ideal place for a fortification: on three sides it is surrounded by the River Elz and the slopes are mostly nearly vertical. It can only be entered from the northeast, the saddle of the ridge. The plateau is of an almost triangular form and has an area of 0.49 ha. The narrow ridge in the northeast has been changed artificially in two places, and at least the inner moat has been built for the castle.

Directly behind the moat in the northeast is the highest part of the castle, a rock that has been artificially levelled. The levelling led to a triangular plateau of 25 × 10 metres. To the west is a flat step to the rest of the castle´s plateau. The southern edge of the big plateau in the south is a rocky ridge about one metre high. The plateau, slightly descending to the north is exceptionally even. The edges in the north and west seem to be the remains of an earthwork. In only two parts of the 'Alte Burg' there are remains of stone walls.

The overall impression of the 'Alte Burg' can be summarized as follows: The terrain which according to the findings was in use as a fortification or fortified settlement in prehistoric times could have been in use by the besiegers of Castle Eltz because of its favourable position. The stone wall on the western side seems to date from the Middle Ages because of its construction. It is not clear in which phase the big plateau was created but the space would be enough for the soldiers and equipment necessary in a siege. The terrain was very well protected and the second siege castle, Trutz-Eltz, provided additional protection (fig. 7).

Fig. 9 Stone balls in Castle Eltz, maybe thrown from the 'Alte Burg' (2008).

At this point two main questions arise:

- Why would Archbishop Balduin build not only one, but two siege castles? Why did he spend more time and more money?
- Why could the besiegers build a big tower or a small castle out of stone (i.e. Trutz-Eltz)? To erect stone walls takes a lot of time – why didn´t the besieged stop them?

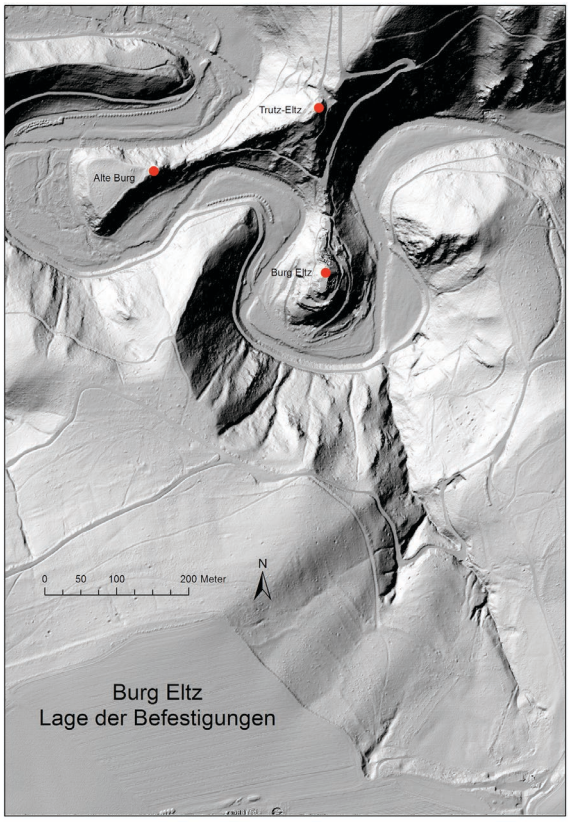

Fig. 10 Castle Eltz, LiDAR-scan of the surrounding area (2010).

Maybe it is possible to find an answer to these questions if we try to analyse the LiDAR-scans in direct comparison with the written sources. If we consider the place where Castle Eltz was built, a small rock in the middle of a deep valley, it is not surprising that even from a tower thirty meters high placed in the castle you cannot see too much of the surrounding terrain. Even the northern flank of the ridge where Trutz-Eltz and the 'Alte Burg' are situated cannot be seen (figs. 10 and 11).

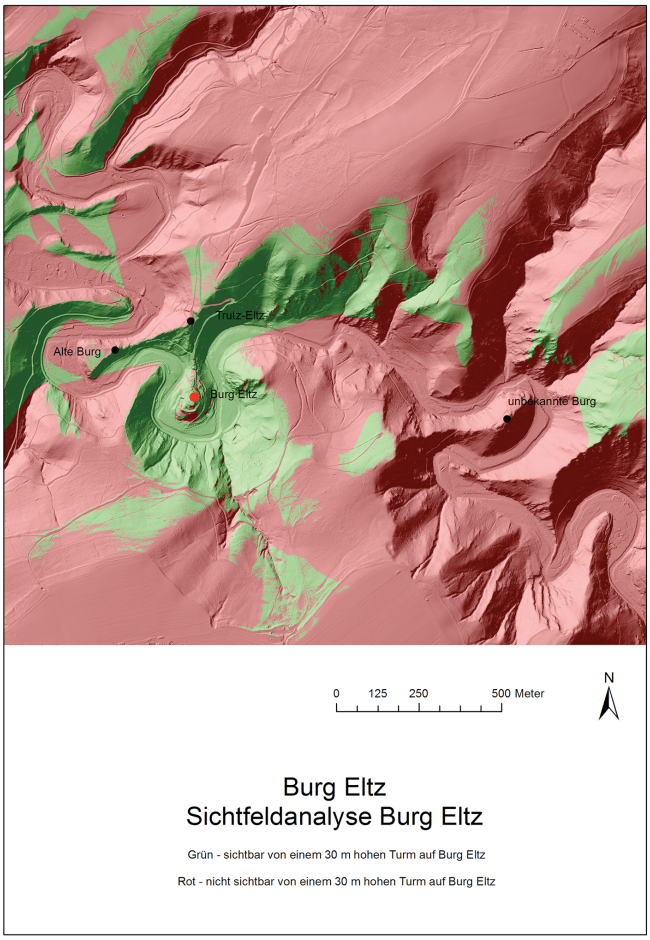

Fig. 11 Castle Eltz, LiDAR-scan, green are the areas that can be seen from a tower of 30 m height in Castle Eltz (2010).

If we now take a look at what could be seen from the place of the 'Alte Burg', we do not reconstruct any tower because there are no hints of the existence of one but we create the space which could be seen by a person, i.e. from two metres height. Not much terrain can be overviewed from there but at least the main entrance of Castle Eltz in the north and the building place of Trutz-Eltz are both visible (fig. 12). From the place where Trutz-Eltz has been built we can also see only a small portion of the surrounding country. But at least Castle Eltz and the 'Alte Burg' can be seen and the valley of the River Elz is visible both in the west and the east of Castle Eltz. The rising ridge in the northeast of Trutz-Eltz can only be viewed in parts (figs. 13 and 14).

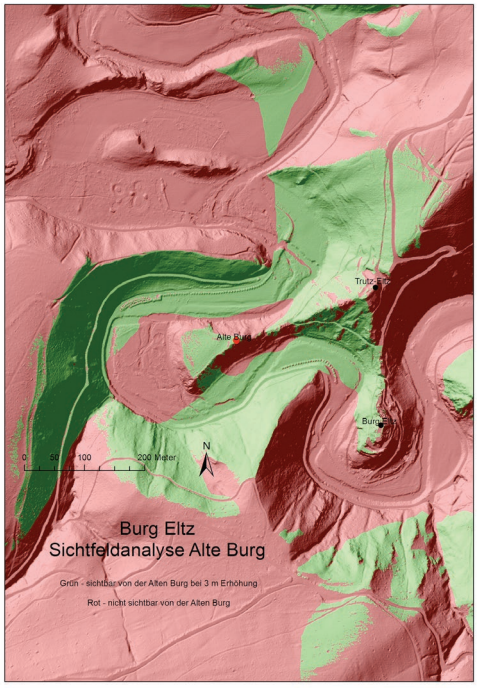

Fig. 12 Castle Eltz, LiDAR-scan, green are the areas that can be seen from a person standing on the 'Alte Burg' (2010).

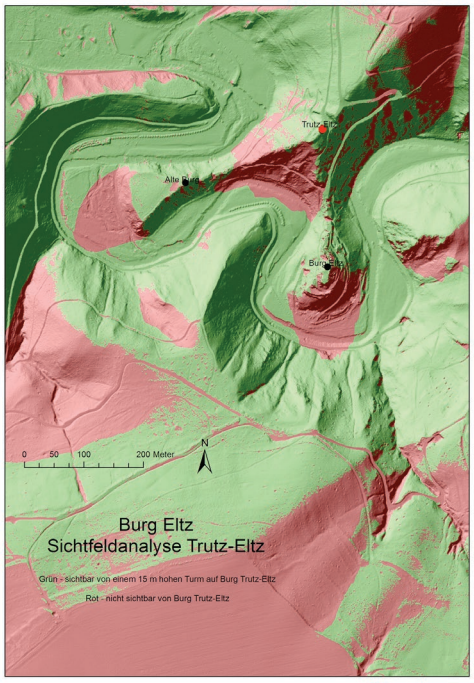

Fig. 13 Castle Eltz, LiDAR-scan, green are the areas that can be seen from a tower of 15 m height on Castle Trutz-Eltz (2010).

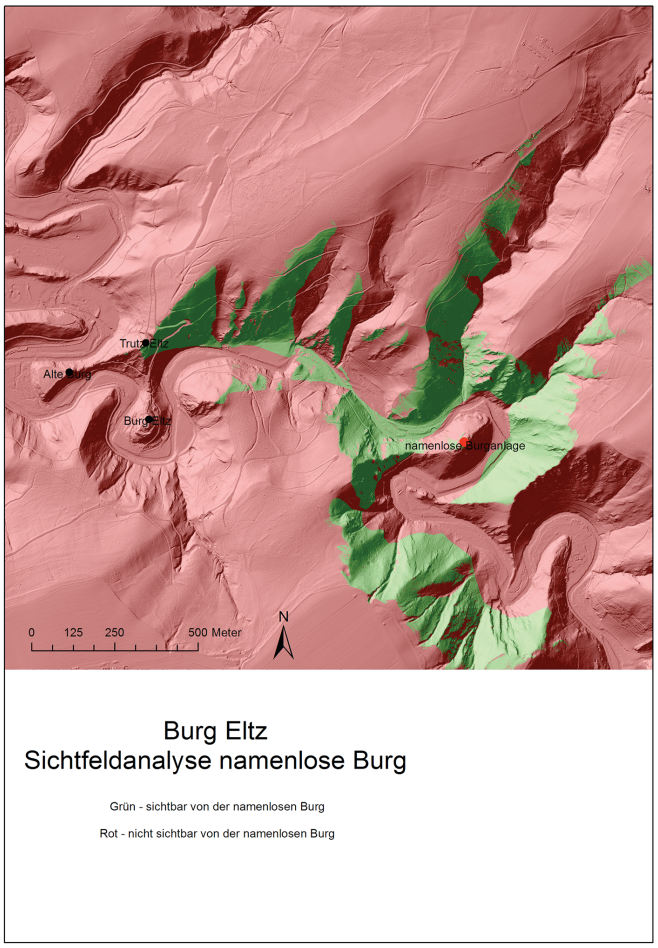

Fig. 14 Castle Eltz, LiDAR-scan, green are the areas that can be seen from a person standing on the nameless castle (2010).

If we now combine the two viewpoint-analyses we can reconstruct what it meant if both the 'Alte Burg' and the place where Trutz-Eltz in a later stage of the siege was built were in the hands of the besiegers: It is clearly visible that the written sources are confirmed because in this case Castle Eltz is surrounded – it is no longer possible to get into the castle without taking the risk to be seen by the besiegers. That does definitely not mean that Castle Eltz was totally blocked off from the outer world because then it would not have been possible to hold out for six years. But it shows that everybody who wanted to enter the castle had to take a risk, a risk they would have been aware of, because they would have seen the fortifications of the besiegers while nearing the castle and known they would have been equally visible.

These facts might be part of the answer to the second question: if the besieged had tried to attack the building site of Trutz-Eltz they would have been caught between the two fortifications of the Archbishop of Trier. They would not have been sure if there was a way back into the castle.

If we now combine these theories with the fact that Trutz-Eltz is a very outstanding siege castle because it comprises a complete donjon, it becomes clear that the whole affair was magnificently planned by Archbishop Balduin: without doubt the tower of Trutz-Eltz was a symbol which showed the besieged that the archbishop had invested (and could afford) much money in this siege. He would not withdraw before he had achieved his aims. But it is even more important that this symbol did not only function in regard of the people in the besieged castle but also in regard of everybody who wanted to reach the castle. It does not matter if you come from the heights in the northeast or through the valley of River Elz from north or west – the first thing you see is not Castle Eltz itself but the tower of Trutz-Eltz.

This case shows how LiDAR-scans can help us to interpret and understand written sources and questions concerning medieval castles. But that is only a first step. The second step would be to try to reconstruct what Trutz-Eltz could have looked like and to integrate such a virtual reconstruction into the LiDAR-scans. Then we could even show not only that the passer-by could see Trutz-Eltz but we could also present what the castle looked like from their point of view no matter which way they took to reach the castle.

This problem will be shown in a second example, Castle Stahlberg. Stahlberg is situated in the Middle Rhine Valley in Rhineland-Palatinate near Bacharach, some kilometres away from the Rhine itself. The castle has been built on a ridge which leads roughly from the northwest to the southeast between two deep valleys, one in the southwest and the other in the east and north.

According to dendrochronolgy the castle´s oldest parts date from around 1156 to 1165. Many parts of that time have survived:[15] First there is a round tower in the northwest of the castle, next to the entrance and directly above the moat. The main parts of the enceinte in the east date from this phase, too, as well as a second big tower which was built on a square ground plan and is situated on top of a small rock. Directly to the north of this tower two buildings can be found which are built on top of the enceinte: A chapel with a half-rounded apse and behind that to the north a big building with residential function, a so-called 'Palas'. To the south a tower provided access from the lower court to the chapel. Most parts of the enceinte in the west are younger and there are foundation walls of some more buildings which have not been identified yet (figs. 15-18).

It is not quite clear who built the castle because the first written evidence is from the year 1243, nearly one hundred years after the main parts were erected.[16] Most probably either the archbishops of Cologne or the Pfalzgrafen, a very important family of the higher nobility, were responsible for the building of this castle. That would also be a possible explanation for its outstanding architectural form with two main towers and a 'Palas' even in the 1160s.

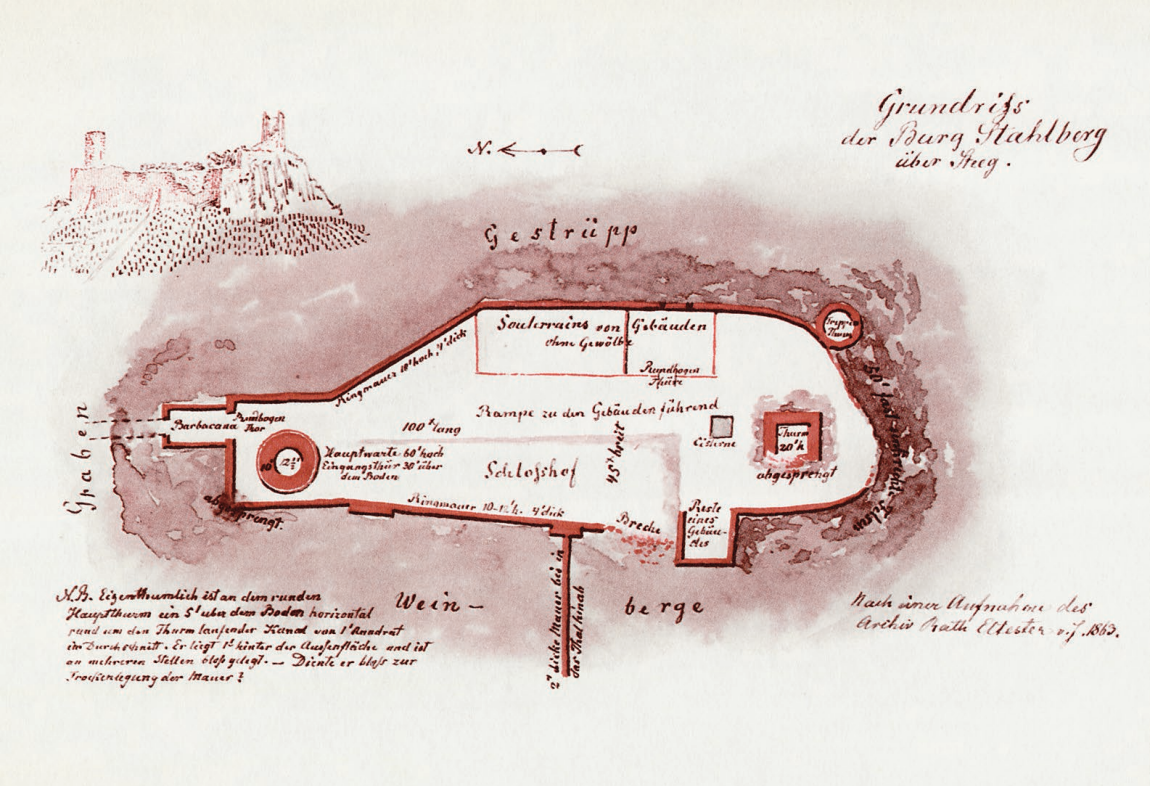

Fig. 15 Castle Stahlberg, plan from Leopold von Eltester, 1863.

Fig. 16 Castle Stahlberg from the west (2005).

Fig. 17 The round tower of Castle Stahlberg from the courtyard (2012).

Fig. 18 The round tower of Castle Stahlberg from the northwest (2005).

Today you must be careful not to miss the castle: only a small road leads up the valley in the west and from there another even smaller road branches off to the east and rises on the heights. It is then when you are just about two or three hundred metres away from the castle that you can see it. You get an impressive view from the northwest and you can see the round tower in the foreground at left and the square tower in the background at the right – the picture of a big castle with two main towers.

Fig. 19 The old road from Steeg to Castle Stahlberg today (2012).

But that road is a new one – in the Middle Ages the way from the town of Steeg to the castle went through the other valley where today there is only a small path (fig. 20). You can still see the former road because of the substructures but you cannot see the castle from there because of the woods. This way leads you up from the church of Steeg to the north and it follows the castle´s ridge in a northwesterly direction, slightly rising all the way. In the north of the castle it suddenly turns to the south and the passer-by is lead directly to the moat with the enceinte and the round tower behind it. This way was obviously arranged to impress the passer-by and to show them the architecture of this big castle because they are lead alongside the chapel and the 'Palas'. So consequently Achim Wendt who discovered the chapel tried to reconstruct what the tower, chapel and 'Palas' would have looked like for the passer-by when they were still intact and there were no woods (figs. 16 and 21-24).[17]

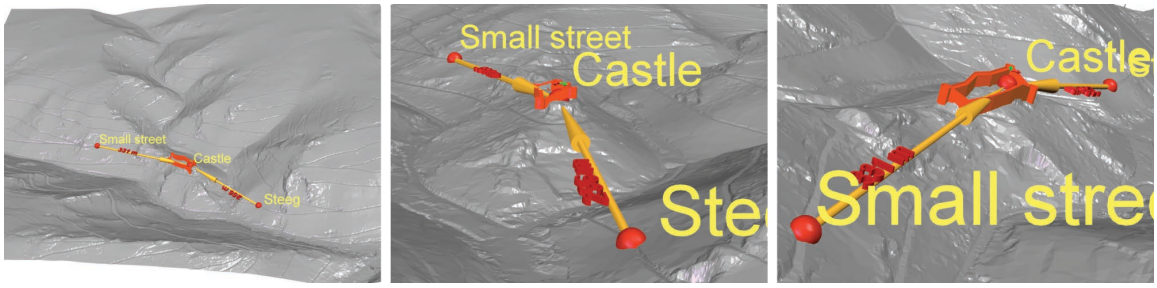

Fig. 20 Castle Stahlberg, schematic 3D reconstruction and distances and views from below, from Steeg (256 m), and from above, from Small Street (331 m), (2010).

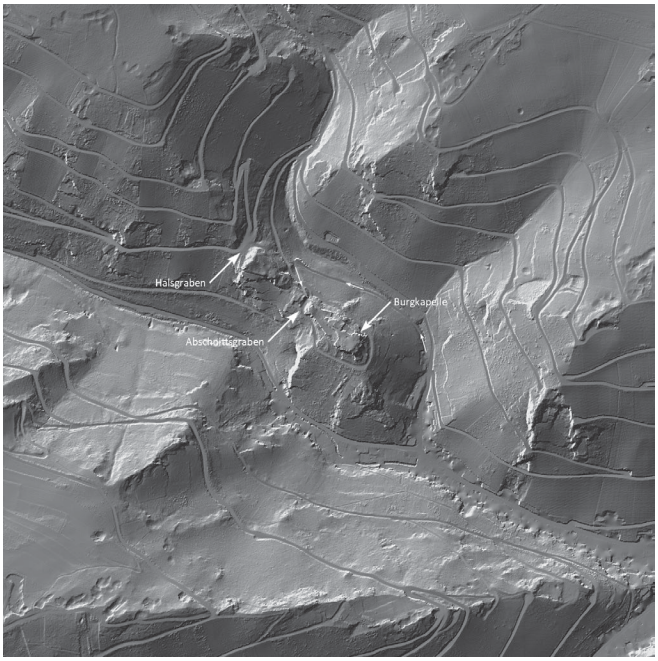

Fig. 21 LiDAR-scan of Castle Stahlberg and its surroundings (2011).

Fig. 22 Castle Stahlberg, building phases of chapel and 'Palas' (2011).

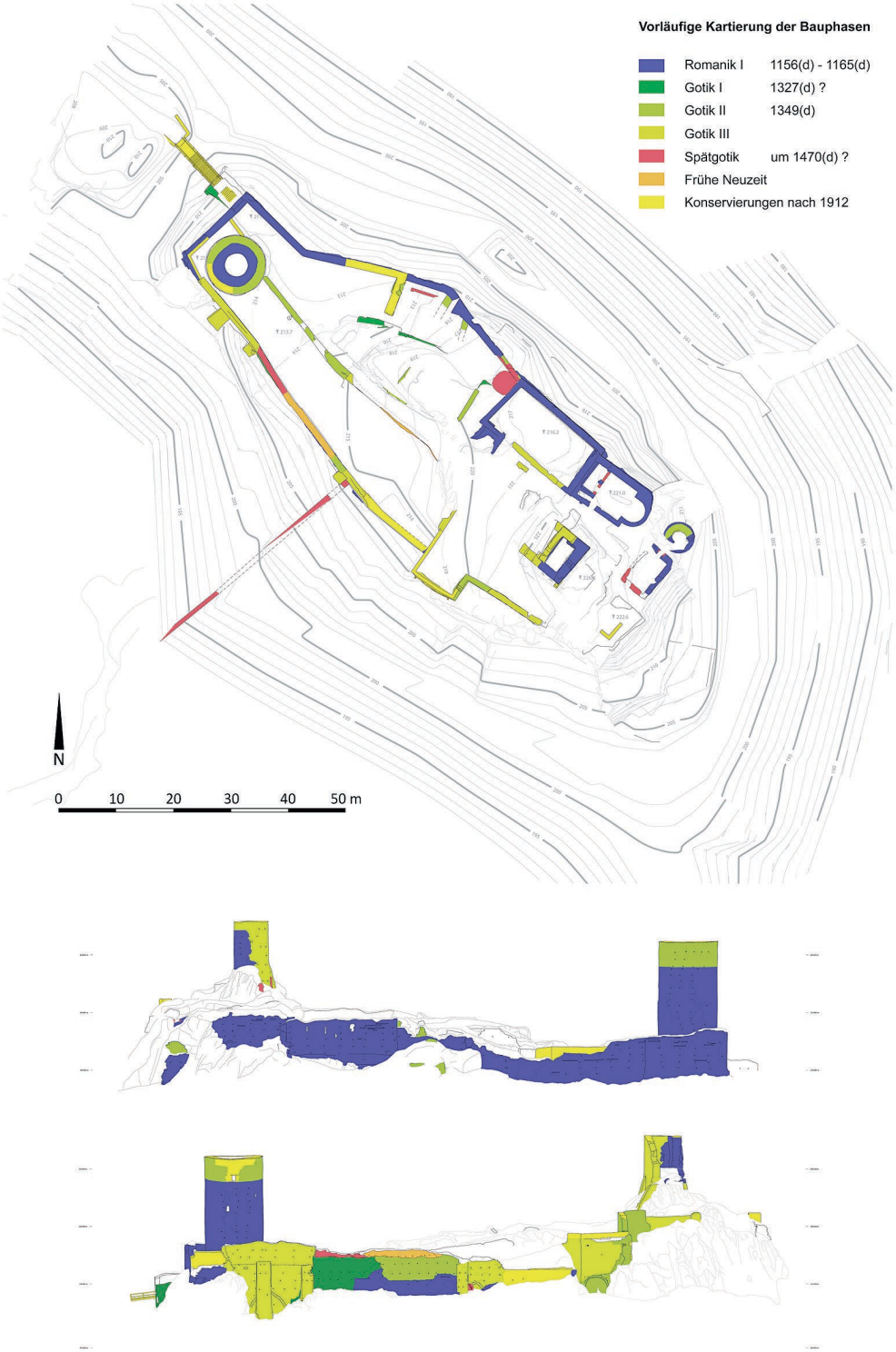

Fig. 23 Castle Stahlberg, building phases (2011).

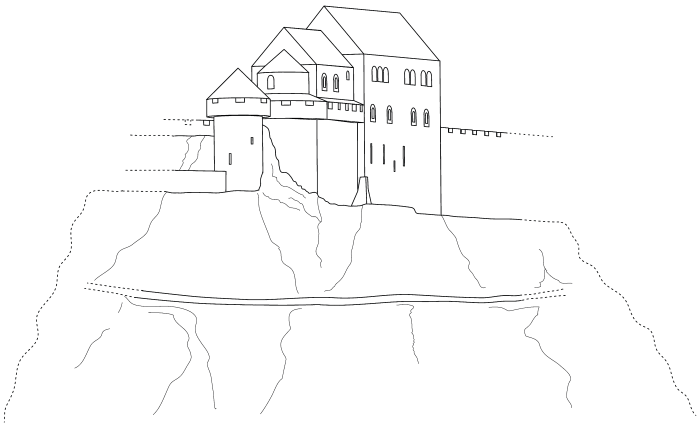

Fig. 24 Castle Stahlberg, reconstruction drawing of chapel and 'Palas' (2011).

Such illustrations are indeed quite helpful to show, and to analyse, what the contemporary viewer would have seen at the time. Going one step further, not only can many illustrations be derived from a full 3D reconstruction of the medieval castle and landscape, but even a series of such reconstructions accounting for the variation over time (4D reconstruction). This requires a very efficient method for the serial production of castle reconstructions, which is not possible using normal off-the-shelf 3D modelling software. Instead the authors have used the so-called Castle Construction Kit from TU Graz[18] for a first proof of concept for future projects. Based on the GML technology from Havemann[19] it gains its efficiency in 3D modelling from a procedural (generative) approach that allows plugging together parametric 3D building elements in a LEGO-style manner. The elements have built-in intelligence so that they can snap together geometrically, and each part can also be configured with a set of high-level parameters. Future projects should use the same method, however they will have to develop the prototype software further by adding more and more sophisticated and diverse geometric elements for castles (fig. 25).

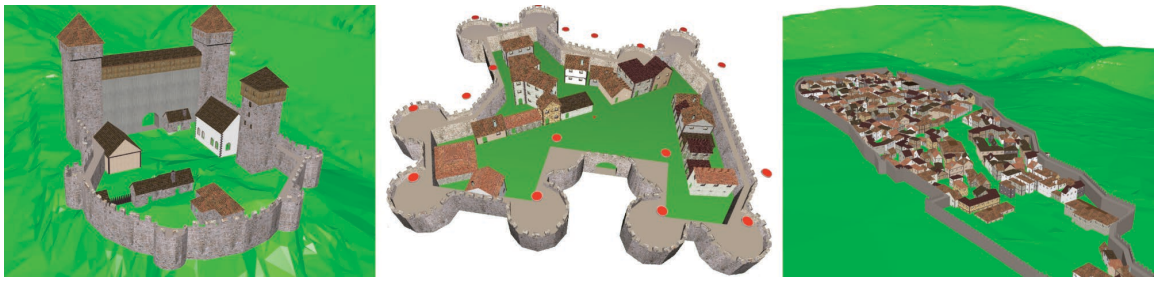

Fig. 25 Geometric building blocks of castles are snapped together to produce 3D reconstructions efficiently, up to the size of whole villages, according to facts and findings and adapted to the terrain (2005).

What is the use of such historic 3D reconstructions? We will show how the whole castle developed in the eyes of the passer-by coming nearer and nearer to the castle and how for example the two main towers rise in the background of chapel and 'Palas'. As we can choose the position of the point of view in the LiDAR-scans, we can take a view from different positions on the old road which led to the castle, i.e. we can reconstruct the situation as realistically as is possible. So we are able to create the real impression the castle may have left on the people in the Middle Ages – and that is even more important for art historical questions: Often virtual 3D models are very nice to look at, especially because you are able to fly around them and take a glance from every point of view as if sitting in a plane – but nobody tries to reconstruct what the people in the time of the building phase could see! How can we try to understand geometric figures of a ground plan of a complicated building if we look at the building in a way which was not possible for its contemporaries?

Using modern technology it is also possible for the historian to get an idea of what the view from a tower or any other part of the castle could be. To achieve this, the authors used a small multirotor UAV, normally used for the documentation of archaeological excavations, to reconstruct the view from the south eastern tower.[20] The day of the acquisition was very windy so a steady flight was impossible and we had to fly in manual mode and needed the support of H. Altenbach and A. Paulski watching the drift of the UAV from different sides. The resulting panoramic view nonetheless shows an impressive view into the valleys and the church of Steeg is also visible. The view was calculated from eight photos, shot by a Samsung NX-100 system camera with a 30 millimeter lens at an altitude of 20 meters above the castle floor. For the panoramic view we used the opensource-software 'Hugin'.[21]

A third example can show the use of the photogrammetry for analyses of castles. The idea is to use the so called 'Structure-From-Motion' (SFM) approach, which uses methods of Photogrammetry to reconstruct a three-dimensional object by a set of photos taken from different positions all around the object, to record a whole castle in 3D. This ambitious effort took place in March and June 2012 without using a UAV, which is still pending.

All in all, the authors shot about 1700 photos with a Canon 550D (18MPx), a Nikon D5100 (16MPx) and a Nikon D90 (12MPx) from different locations from the enclosed area, from the modern tower and all around the castle, moving only just a few meters at a time. It is necessary to check the photos afterwards for the correct exposure and white-balance in all areas, which is done using the particular software coming along with the cameras.[22] For the processing of the images we use VisualSFM by Changchang Wu from the University of Washington[23] which is freely available for academic use, although not open-source.

The next steps towards a 3D model are to find corresponding points in the photos, so every single photo has to be analysed and matched. After this step the software calculates back the positions of every photo. This step produces a sparse point cloud, showing a first rough 3D model alongside the positions of each photo. This data is used to calculate a dense model of the

object, which takes some time, especially when using a large set of images as in this case. The following calculations were done on a high-performance PC at the Interdisciplinary Center for Scientific Computing at the Heidelberg University. The calculation of the corresponding points took 24 hours, while the sparse point cloud was ready after 20 minutes. The following calculation of the dense point cloud took another 24 hours.

Fig. 26 The quadrocopter at the takeoff position (2012).

Fig. 27 The quadrocopter flying at Stahlberg castle. The camera mounted is a Samsung NEX-100 (2012).

Using this dense point cloud the surfaces of the model can be reconstructed using the 'Poisson Surface Reconstruction' coming along with the open-source software 'MeshLab', developed by the Visual Computing Lab at 'Instituto di Scienza e Tecnologie dell'Informazione "A. Faedo"', Pisa.[24] The resulting model consists of 7.8 million points and 14.7 million triangles (faces) but is also showing some areas where no points could be reconstructed, usually because photos from above would be necessary, for example the moat in the north of the castle, as well as the whole area of the well in the north western castle area. The views from the tower are missing or their viewing angle became too flat for the calculation (figs. 26-41). Therefore the authors are planning to do another visit some time in 2015 using UAVs to acquire the missing parts of the castle and providing additional information to the existing calculations.

Fig. 28 ArchEye's quadrocopter flying over the castle Stahlberg (2012).

Fig. 29 View over castle Rauschenburg showing remains of the turret and the walls (2012).

Fig. 30 View from castle Stahlberg showing the church of Steeg (2012).

Fig. 31 A different view from above castle Stahlberg showing the church of Steeg (2012).

Fig. 32 Stahlberg, panoramic view, almost 360 degrees field of view (2012).

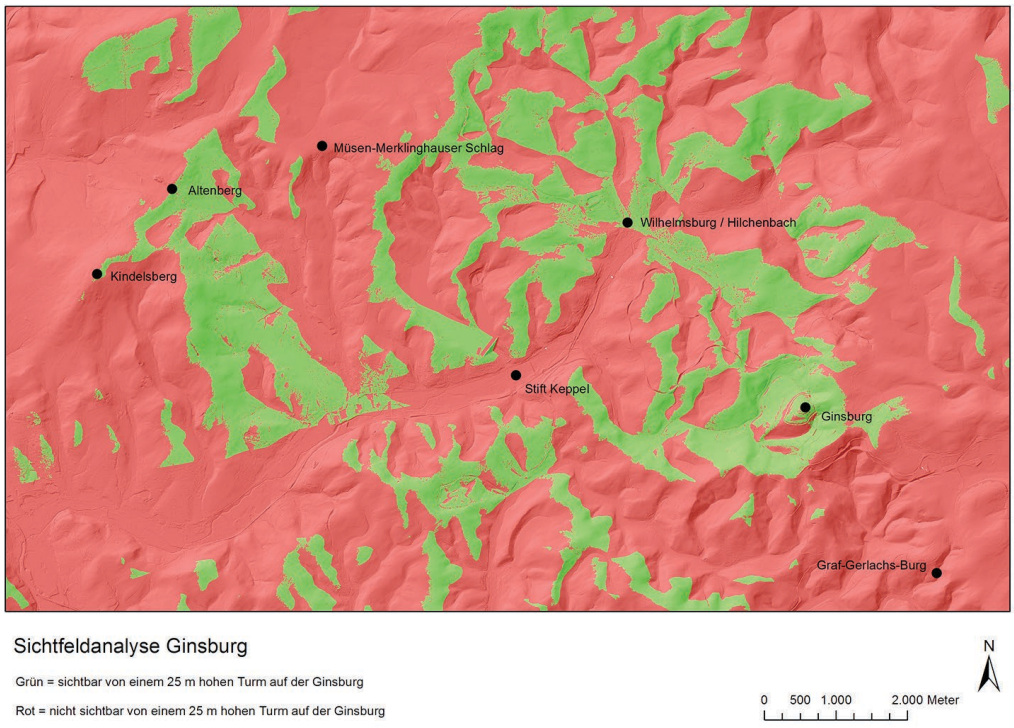

Fig. 33 LiDAR-scan of Ginsburg Castle. Green is what you can see from a tower of 25 m height (2012).

Fig. 34 Ginsburg, 3D model, detail of the northern castle wall (2012).

Fig. 35 Ginsburg, 3D model, view on the courtyard and the basement of the 'Palas' (2012).

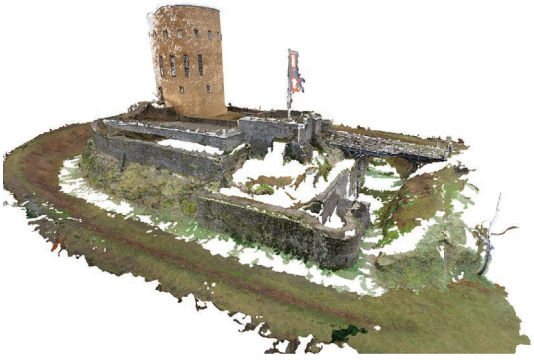

Fig. 36 Ginsburg, 3D model, view from the northwest (2012).

Fig. 37 Ginsburg, 3D model, view from the east (2012).

Fig. 38 Ginsburg, 3D model, view from the south-southeast (2012).

Fig. 39 Ginsburg, 3D model, view from the south-southwest (2012).

Fig. 40 Ginsburg, 3D model, top view in orthographic projection (2012).

Fig. 41 Ginsburg, 3D model, view from the north (2012).

We will use the UAVs of the 'Project ArchEye' and its successor, the PhD-Project 'ArchEyeAutomatic'.[25] Two UAVs are available at the moment, one six-engine driven so-called 'Hexacopter' in coaxial engine order[26] and a bigger eight-engine 'oktocopter'. Both UAVs are based on the electronics developed and distributed by the German MikroKopter UAV platform,[27] consisting of a board for flight attitude regulation and a board for navigation functions with GPS-navigation and waypoint-navigation. The UAVs can carry a payload between 1.0 and 2.5 kilograms, allowing them to lift even a bigger reflex camera for up to 15 minutes. The UAVs can fly along a route calculated beforehand, concerning camera, lens and a target resolution on the ground and therefore trigger the camera at the right spots to get the photos necessary for the calculation of the 3D model.[28] Additionally it is planned to use ground control points to get a scaled and geo-referenced model of the castle.

The finally resulting model can be integrated into a GIS as a more precise starting point for viewshed-analysis, or even as a basis for a virtual reconstruction using an enhanced version of the Castle Construction Kit. We are convinced that we have the opportunity to broaden and deepen the art historical analyses and discourse with the help of LiDAR-scans and virtual reconstructions. They will enable us to obtain a new quality of insights and understanding of the tight relation of architecture and landscape so that we can create a new understanding of landscape for art history.

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Illustrations

Fig. 1-4, 6, 7, 9 Olaf Wagener 2008.

Fig. 5 Planarchiv der Generaldirektion Kulturelles Erbe Rheinland-Pfalz, Mainz.

Fig. 8 GML-Rendering of LiDAR-scan: Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz, 16.12.2010, AZ. 0322 28101 / 519336; analysis: Sven Havemann (GEO-Tiff Daten).

Fig. 10-14 LiDAR-scan: Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz, 16.12.2010, AZ. 0322 28101 / 519336; analysis: Olaf Wagener.

Fig. 15 Wendt 2011, p. 156.

Fig. 16, 18 Olaf Wagener 2005.

Fig. 17, 19 Olaf Wagener 2012.

Fig. 20 GML-Rendering of LiDAR-scan of Castle Stahlberg and its surroundings; analysis: Sven Havemann (GEO-Tiff-Daten). (16.12.2010)

Fig. 21 Wendt 2011, p. 153.

Fig. 22 Wendt 2011, p. 175.

Fig. 23 Wendt 2011, p. 157.

Fig. 24 Wendt 2011, p. 190.

Fig. 25 Castle Construction Kit from Gerth / Berndt / Havemann / Fellner 2005.

Fig. 26-28, 30, 31 Anne Paulski 2012.

Fig. 29, 32, 34-41 Christian Seitz 2012.

Fig. 33 LiDAR-scan: Geobasisdaten der Kommunen und des Landes NRW © Geobasis NRW 2012; analysis: Olaf Wagener.

[1] Concerning LiDAR-scans see Dorn and Wagener 2009, pp. 36-40 and Höfle and Wagener 2012.

[2] See Seitz and Wagener 2012 for details.

[3] Wagener and Schmidt 2013; Wagener and Schmidt 2010/11; Wagener 2006, pp. 368-372.

[4] For background information to the conflict and the politics of Archbishop Balduin of Trier see Eulenstein 2006 and Eulenstein 2007.

[5] Eulenstein 2006, pp. 84-87.

[6] Günther 1825, n. 242, pp. 495-498, especially p. 495 f. ‚[…] von desselben [=Erzbischof Balduin] vnsers Furfaren seligen Gezyten bysher vnbewonet vnd dadurch verwustet vnd vergenklich worden [...]'.

[7] Wagener 2003, p. 172 and Scholz 2004, pp. 240-248.

[8] Wyttenbach and Müller 1836-1838, vol. 2, p. 251. Translation in Zenz 1961, p. 55: 'Gegen sie zog Herr Balduin mit Heeresmacht zu Felde, schloß Eltz ein und befestigte das neu erbaute Baldeneltz in ganz erstaunlicher Weise. Hierdurch vernichtete er die Macht von Eltz.'

[9] Thon and Ulrich 2007, p. 53.

[10] See Kirchschlager and Stolle 2006.

[11] In the last years art historical research took place in Castle Eltz, oral information from Lorenz Frank, Mainz. A publication of the results is intended.

[12] See Urban 1996, pp. 69-71; Wagener 2003 p. 171 f.; Wagener and Schmidt 2010/11, pp. 219-230.

[13] This phase can in its dimensions and structure be compared with the so-called Aachener Schanze, a siege castle against Castle Rheinberg in the Wisper Valley near Mainz, built 1279/80, see Wagener 2006, pp. 362-365. It is not easy to judge how much space a trebuchet needed, see Küntzel 2006, pp. 357-360.

[14] See Speight 2000 and Wagener 2006.

[15] See Wendt 2008 and Wendt 2011.

[16] Koch and Wille 1894, p. 27, n. 489; Knipping 1909, p. 163, n. 1099.

[17] Wendt 2011, p. 190.

[18] See Gerth et al. 2005 for details.

[19] See PhD thesis Havemann 2005 for details.

[20] The UAV is from 'Project ArchEye' at Heidelberg University, operated by C. Seitz: www.archeye.de.

[21] http://hugin.sourceforge.net.

[22] In this case we used 'ViewNX' for photos coming from the Nikon cameras, while the photos of the canon where processed using 'Digital Photo Professional'.

[23] Wu, Changchang, 'VisualSFM: A Visual Structure from Motion System', http://ccwu.me/vsfm/, 2011 and Wu et al. 2011.

[24] http://meshlab.sourceforge.net.

[25] The PhD-project is realized at the working group 'Optimization in Robotics and Biomechanics' (ORB) at the Interdisciplinary Centre for Scientific Computing, Heidelberg University. Supervisors are Prof. Katja Mombaur (ORB) and Prof. Matthias Untermann (Institute of European Art History, Heidelberg University).

[26] In this constellation, the UAV has three arms with two paired engines, one facing to the top and the second to the ground, rotating in different directions and thus minimizing vibrations but also resulting in a more compact design.

[27] www.mikrokopter.de.

[28] This software was developed by C. Seitz for Project ArchEye.